NOAA National Centers for Environmental Information Topo-Bathymetric Digital Elevation Modeling: North Carolina (Cape Lookout to NC/VA border)

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Introduction

This report briefly describes the creation of a suite of tiled Digital Elevation Models (DEMs) developed along the North Carolina coast in 2018 by the NOAA National Centers for Environmental Information (NCEI; Fig. 1). This work was funded by the National Weather Service under the auspices of the COASTAL Act to improve NOAA's storm surge modeling capabilities.

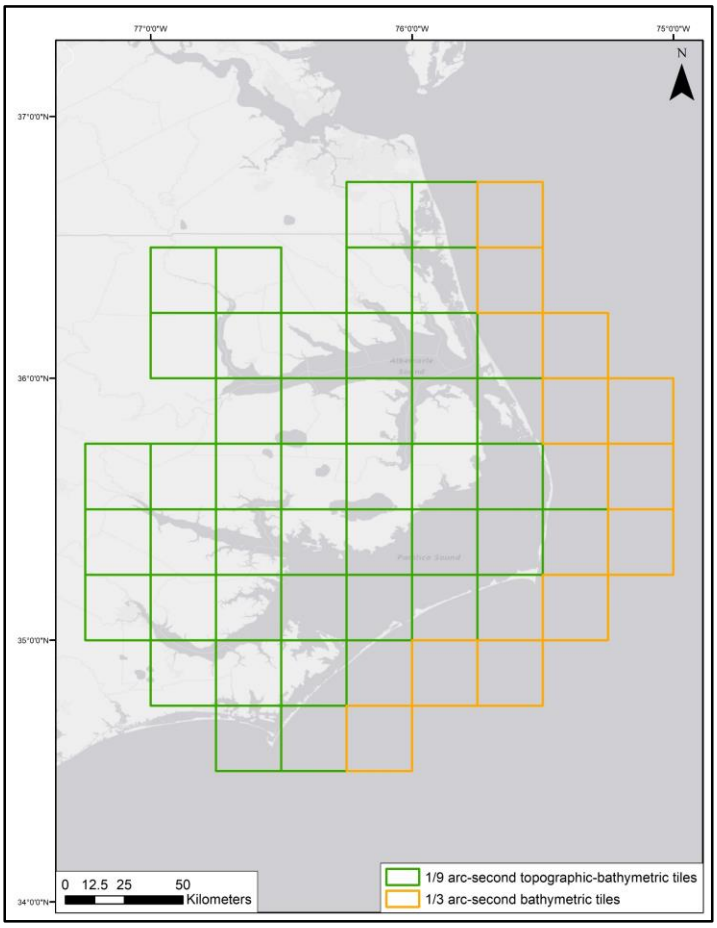

Figure 1. Spatial Extent of the 2018 NOAA NCEI North Carolina DEM suite.

Fifty-seven tiled DEMs were created in the area of interest: 46 with a spatial resolution of 1/9 arc-second and 11 with a resolution of 1/3 arc-second. Only the 1/9 arc-second DEMS tiles integrate topography and bathymetry. The DEM tiles represent the best available coastal elevation data at the time of their creation; the intent is to update specific tiles as new survey data becomes available. The utilization of a tiling scheme in developing the DEMs is designed to improve data management during source data processing as well as facilitate targeted DEM updates.

The final integrated 1/9 arc-second topography-bathymetry DEM tiles and 1/3 arc-second bathymetry tiles are referenced to the North American Vertical Datum of 1988.

Data Processing

Original source topographic and bathymetric data were collected by a variety of federal and state agencies, including NOAA, the United States Geological Survey (USGS), US Army Corps of Engineers (USACE) and the State of North Carolina Floodplain Mapping Program. Source data were obtained in a variety of different formats and referenced to disparate horizontal and vertical datums (Table 1).

Table 1. Source datasets used in the creation of the NOAA NCEI Florida Keys Tiled DEM suite

Source Dataset	Data Type	Acquisition Date	Horizontal Datum/Projection	Vertical Datum	Notes
North Carolina Floodplain Mapping Program Topographic Lidar	Topographic Lidar (gridded)	2014	NAD83	NAVD88 (geoid 12b)	DEMs integrating 2014 NCFMP topo lidar with 2014 NGS topo-bathy lidar created and distributed by NOAA Office for Coastal Management (OCM)
NOAA National Geodetic Survey Topographic-Bathymetric Lidar	Topographic-Bathymetric Lidar (gridded)	2014	NAD83	NAVD88 (geoid 12b)	See above
NOAA National Ocean Service Hydrographic Survey Data	Bathymetric soundings and gridded bathymetry	1851-2016	NAD83	MLLW	Bathymetric Attributed Grids: D00158, F00536, H11568, H12061, H12202, H12203, H12265, H12266, H12285, H12306, H12307, H12316, H12341, H12342, H12343, H12839, H12840, H12841, H12843, H12858, H12859
USACE Channel Condition Surveys	Bathymetric soundings and charted information	2015-2018	WGS84	MLLW	
United States Geological Survey Interferometric Sonar	Gridded bathymetry	2008	WGS84 UTM Zone 17	MSL	USGS Open-File Report 2011-1015

All source data were converted to a common horizontal of North American Datum of 1983 using a combination of various Geospatial Data Abstract Libraries (GDAL) utilities (using spatial reference information defined by various codes maintained by the European Petroleum Survey Group (EPSG)) and the NOAA VDatum software utility, depending on the dataset in question. The vertical datum of bathymetric datasets referenced to Mean Lower Low Water (MLLW) were converted to the North American Datum of 1988 (NAVD88; Geoid12B) for consistency with topographic data already referenced to NAVD88.

All data were converted to a common data format (ASCII xyz) in preparation for gridding. If a dataset was obtained in a raster format, it was resampled using a bilinear resampling algorithm to match the target spatial resolution of the affected tile, then converted to ASCII xyz using GDAL. All data was reviewed and evaluated for internal and external consistency with adjacent data. Anomalies were identified and removed through visual inspection and automated filtering.

MB-System's 'mb-grid' utility was used to create an initial bathymetric surface at a resolution of 1/3rd arc-seconds (see Carignan et al., 2011 for a detailed description of the process). A tensioned thin-plate spline algorithm was used to interpolate depth values in pixels within the DEM extent that were unconstrained by elevation measurements. Constrained pixels were assigned a final elevation value based on the Gaussian weighted average of the input source elevation measurements. Datasets were preferentially weighted to minimize the influence of lesser quality data. Given the disparate nature of the source bathymetric data, a 2-D Gaussian convolution filter was applied to the bathymetric surface in order to minimize offsets among adjacent datasets.

For tiles that do not integrate topography and bathymetry (e.g. all 1/3rd arc-second resolution data), the smoothed surface is the final product. In cases where both bathymetry and topography are mapped, the smoothed bathymetric surface was resampled to 1/9th arc-seconds and converted to ASCII xyz format. The final seamless bathy-topo elevation surface was created using Generic Mapping Tools (GMT) 'Surface' gridding utility, with the topographic and bathymetric surface xyz data serving as the inputs.

Final DEM tiles were qualitatively evaluated to identify anomalous data points, as well as compared with imagery and NOAA Raster Nautical Charts. If necessary, persistent anomalies were cleaned from the input source data and the DEM tile was re-generated using the previously described processes. No quantitative analysis was performed to assess the accuracy of the DEMs, although this continues to be an area of active research at NCEI (see Amante and Eakins, 2016).

For more information, contact dem.info@noaa.gov

References:

Amante, C.J. and Eakins, B.W., 2016. Accuracy of interpolated bathymetry in digital elevation models. *In*: Brock, J.C., Gesch, D.B., Parrish, C.E., Rogers, J.N., and Wright, C.W. (eds.), *Advances in Topobathymetric Mapping, Models and Applications. Journal of Coastal Research*, Special Issue, No. 76, pp.122-133.

Carignan, K.S.; Taylor, L.A.; Eakins, B.W.; Caldwell, R.J; Friday, D.Z.; Grothe, P.R. and Lim, E., 2011. Digital Elevation Models of Central California and San Francisco Bay: Procedures, Data Sources and Analysis. *NOAA Technical Memorandum NESDIS NGDC-52*, 49p

Appendix I - Vertical Datum Relationships at selected NOAA Tide Stations in the DEM AOI